Environmental Impact Caused by Open Waste Burning Activity in Asia

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Abstract: Open waste burning (OWB) is a source of short-lived climate pollutants (SLCPs) such as CH4, BC, and CO_2, as well as other primary air pollutants such as total suspended particulates (TSP), carbon monoxide (CO), nitrous oxide (NO^x), and sulfur dioxide (SO_2). This study aims to estimate the total OWB emissions from OWB activity. This study used data from published online reports, global waste-management inventories, and scientific articles. The analysis was conducted based on the IPCC 2006 guidelines, and the equation for estimation was modified from the IPCC. The study found that South Asia became the primary contributor to open waste burning emissions, accounting for 39.5% of the total OWB activities in Asia. Meanwhile, low-to middle-income countries contribute to the highest total burned waste, accounting for 61.2%. The findings highlight the urgent need for policy interventions and alternative waste management solutions to mitigate OWB emissions and their associated health and environmental impacts.

Keywords: emission estimation; open burning; SLCPs; waste management

INTRODUCTION

Open waste burning (OWB) is a common method used to eliminate waste in developing countries worldwide. This practice is preferable because of the lack of a waste collection system, proper waste conversion technologies, and convenient methods to quickly eliminate waste [1]. However, this practice produces environmental consequences such as the release of carbon dioxide (CO_2), methane (CH_4), and black carbon (BC), which are also categorized as short-lived climate pollutants (SLCPs). In addition, OWB can also contribute to an increase in health risks, especially respiratory diseases and cancer, and the emergence of economic risks caused by environmental and health damage to the exposed environment [2]. The calculation of greenhouse gas (GHG) emissions from OWB activity has been used to develop the baseline and inventory [1,3,4]. The oldest inventory publication in global OWB was published by Wiedinmyer et al. in 2014 using data from 2012 [1]. Subsequently, Reyna-bensusan et al. renewed the BC emission factor and conducted a global BC inventory analysis in 2019 [3]. Therefore, the methods used had too many biases. Therefore, robust estimation methods are required to produce a clear baseline to develop a comprehensive waste management system. This study aims to estimate the total number of MSW that is burned openly from the perspective of the subregion and economic level. This study aims to develop scientific recommendations that can be used, especially to reduce the number of open burning activities and their emissions to the atmosphere, while

increasing the sustainability of waste management in Asian countries.

MATERIALS AND METHODS

Data Collection

The data collection process in this study focuses on gathering relevant information to estimate SLCP emissions from the OWB. The required data include activity data such as the total amount of MSW generated per capita, national population distribution (urban and rural), waste collection rates, and the fraction of waste burned openly. In addition, default emission factors for CO_2, CH_3, N_2O, and BC were used, especially when country-specific data were unavailable.

Data Analysis

The collected data were then analyzed to calculate the total amount of OWB and estimate the resulting emissions. The methodology used followed the IPCC calculation methodology, with some modifications to account for waste management practices in each country. The total MSW burned was calculated using an equation that integrates key parameters, such as the fraction of waste that is not collected, the proportion of waste collected and disposed of in open dumps, and the combustion efficiency. Emissions were then calculated by applying emission factors to convert the waste burning data into SLCPs emission estimates. The final results were expressed as CO_2 equivalent values.

RESULTS AND DISCUSSION

Inventory Results

Data analysis showed that the total amount of waste generated in Asia in 2020 reached 1,065,512,863 tons per year, with approximately 256,747,268 tons per year being openly burned. In terms of regions, South Asia had the highest rate of openly burned waste (101,502,520 tonnes/year), followed by Southeast Asia (61,761,343 tonnes/year) and East Asia (72,752,840 tonnes/year). Based on income level, lower-middle-income countries (LMI) contributed the most to openly burned waste, with a total of 157,095,941 tonnes/year, followed by upper-middle-income countries (91,505,042 tonnes/year). Greenhouse gas emissions from open burning reached 51,334.45 tons of CO_2, 1,341.22 tons of CH_4, and 30.95 tons of N_2O across Asia. Overall, the climate change impact of the open burning of waste in Asia is estimated at 351,106.21 tons of CO_2 equivalent (CO_2-eq).

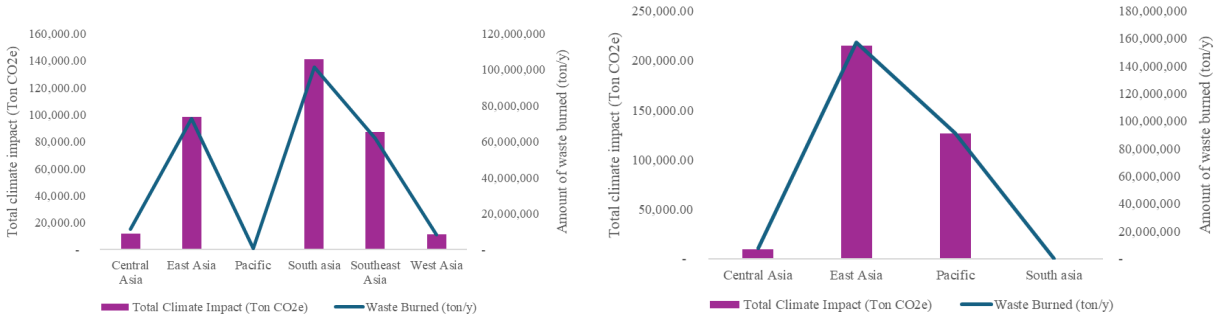

Figure 1. Total climate impact vs total burned waste based on sub region (left) and economic level (right)

Discussions

These results confirm that developing countries still rely heavily on open burning, particularly in South and Southeast Asia, as the primary method of waste disposal. Factors such as low waste collection rates, lack of waste management infrastructure, and a high proportion of rural population contribute to the high prevalence of open burning in these regions. From an emission perspective, the high levels of CH_4 and N_2O produced from open burning are of major concern, as both gases have a much higher global warming potential than CO_2.. In terms of income level, the results of this study support previous findings that lower-income countries tend to have higher levels of waste burning owing to limitations in waste management systems. In contrast, high-income countries have very low levels of open burning because they have implemented better waste management systems such as recycling, controlled incineration, and modern technology-based waste treatment.

CONCLUSIONS

The results of this study indicate that the open burning of waste in South Asia is the highest among Asian countries. With significant emissions, particularly from CH_4, N_2O, and BC, open burning directly contributes to global climate change. Low- and lower-middle-income countries are the main contributors to this practice, owing to limitations in waste management systems. Therefore, a more effective and sustainable waste management strategy is required to reduce the environmental impact of this practice.

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